

Convection Lab

Objective

To investigate and observe how material moves within a convection cell.

Materials

For the class

- ◇ pitchers with room-temperature water placed centrally in the room
- ◇ a source of hot water, enough to fill three cups for each group
- ◇ cleaning supplies to handle water spills
- ◇ food coloring (red, blue, and green)
- ◇ small containers to hold food coloring
- ◇ basin for collecting used water

For each group

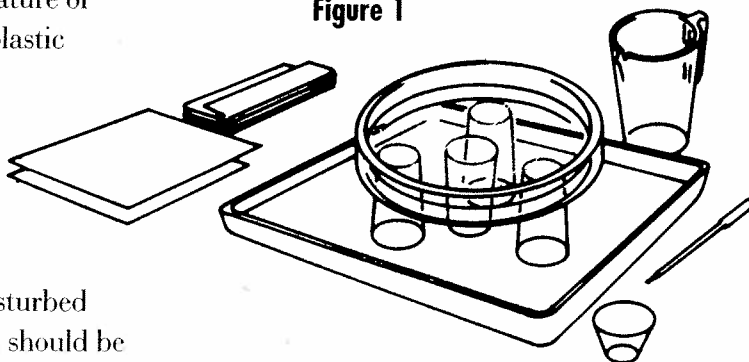
- ◇ a tray
- ◇ a small cup containing food coloring
- ◇ a clear plastic pan
- ◇ a pipette or medicine dropper
- ◇ towels for cleaning the pipette
- ◇ four foam cups (one with lid)
- ◇ two sheets of white paper
- ◇ Data Sheets for each student

Procedure

Setup

1. Select a group member to pick up your tray of supplies.
2. Clear off the tray and line it with white paper. This will make observations of your convection cell easier.
3. Place three of the four foam cups upside down on the paper forming a triangle. The fourth cup eventually will be placed right side up amidst the other three, as in the apparatus shown in Figure 1.
4. Add enough room temperature or cooler water to the clear plastic pan so that it is $\frac{1}{2}$ to $\frac{2}{3}$ full.
5. Place the pan on top of the three upside-down cups.
6. Leave the apparatus undisturbed for several minutes. There should be no ripples in the water when you begin.

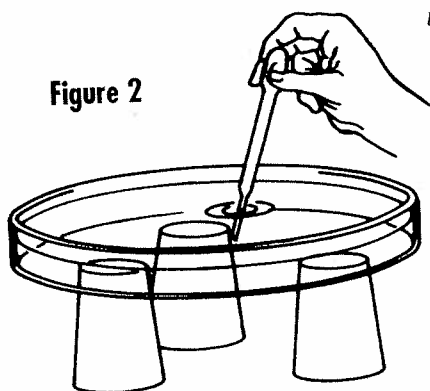
Figure 1



Vocabulary

Convection: The process of heating, rising, cooling, and sinking that many geologists think causes the asthenosphere to flow. A complete cycle is called a **convection cell**.

Figure 2



Trial 1

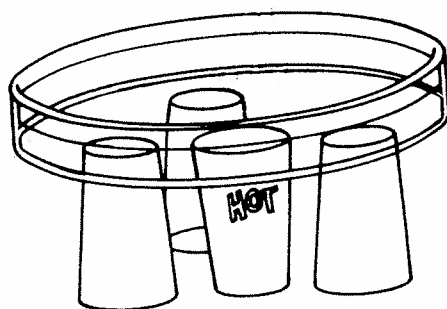
In Trial 1 you will observe the movement of food coloring with no heat source. You will compare the results of future experiments against this *control experiment*.

7. After the water is still, place a small drop of food coloring at the bottom of the pan in the center. To do this, collect some food coloring in your pipette. Carefully wipe off any excess coloring on the pipette's outside. Move the pipette into and out of the water using slow up-and-down motions only. Place the pipette tip at the bottom of the water at the pan's center (Figure 2). *Take care not to create any movement in the water as you insert and remove the pipette.* Slowly release one very small drop.
8. Observe the water for about two minutes, viewing both from the top and from the sides. To improve your observations hold a piece of white paper behind the pan. Record your observations on the Data Sheet (page 76). In the space provided draw what you see happening to the distribution of the food coloring. Use arrows to show the direction of movement.
9. After recording the results of this control experiment, gently swirl the water to disperse the food coloring. You only need to replace the water in your pan if it is too dark for further observations.

Trial 2

In Trial 2 you will observe the movement of food coloring when a heat source is placed directly underneath the pan's center, as in Figure 3.

Figure 3



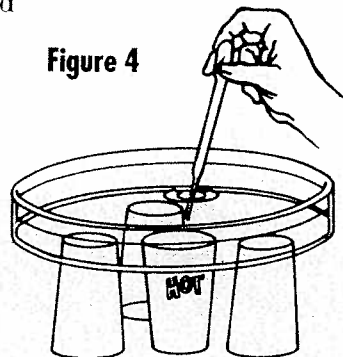
10. After the food coloring from Trial 1 has dispersed, allow the water to become still again.
11. Select one person from the group to retrieve hot water from your teacher in the empty fourth cup. Be certain to use the lid when carrying the hot water back to your table!
12. *Being careful not to disturb the settled water,* gently slide the cup of hot water underneath your pan. Place the cup directly underneath the center of the pan (Figure 3).

13. As in Trial 1, place a small drop of food coloring in the bottom center of the water (Figure 4). Remember to *slowly* release the drop.

14. Observe the water for about two minutes. Record your observations on the Data Sheet. Draw what you see happening to the distribution of the food coloring, using arrows to show the direction of movement.

15. After completing Trial 2, remove the cup containing the hot water from underneath the pan and empty it as directed by your teacher. Replace the pan water with clean, room-temperature water.

Figure 4

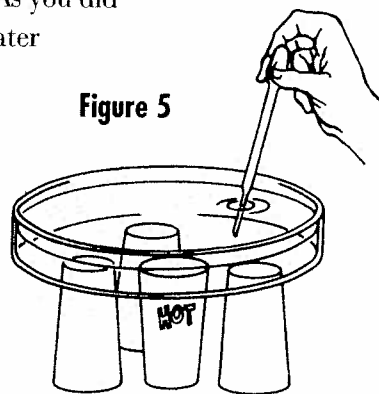


Trial 3

In Trial 3 you will observe the movement of food coloring with a heat source placed under the center of the pan, as in Trial 2. But in this experiment, the food coloring will be placed on the bottom roughly halfway between the pan's center and its perimeter, as in Figure 5.

16. Allow the water in the pan to become still. As you did in Trial 2, select a person to retrieve hot water from your teacher. Take the empty fourth Styrofoam cup and lid again. *Use caution* when carrying the hot water back to your table! As in Trial 2, gently slide the cup of hot water underneath the pan. Place it directly underneath the pan's center.

Figure 5

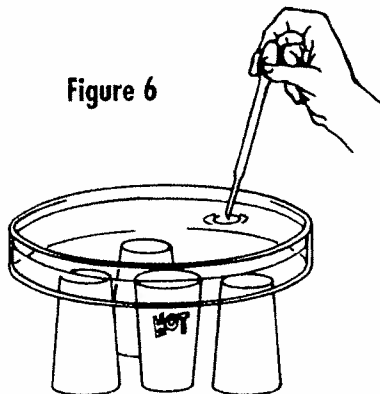


17. Place a small drop of food coloring on the pan's bottom *roughly halfway between the center and the perimeter*. Remember to slowly release the food coloring to avoid disturbing the water.

18. Observe the water for about two minutes. Record your observations on the Data Sheet.

19. When your observations and recording are complete, gently swirl the water to disperse the food coloring. You only need to replace your pan's water if it is too dark for further observations. Remove the cup containing the hot water from underneath the pan and carefully empty it.

Figure 6



Trial 4

In Trial 4 you again will observe the movement of food coloring with the heat source placed under the center of the pan. As in Trial 3, the food coloring will be placed roughly halfway between the pan's center and perimeter. However, instead of being inserted on the pan's bottom, the food coloring now will be placed on the water's *surface*, as in Figure 6.

20. Allow the water to settle. As you did in Trials 2 and 3, and select one person from the group to retrieve hot water from your teacher. (Take the empty fourth Styrofoam cup and lid again, and *use caution* when carrying the hot water back to your table!) Gently slide the cup of hot water underneath the pan's center.
21. For this trial, place a small drop of food coloring roughly halfway between the pan's center and edge. But this time, place the drop *directly on the water's surface*.
22. Observe the water for about two minutes. Record your observations on the Data Sheet.
23. After completing your observations and recording, discard the water. Place all experimental materials on the tray and return them to the spot chosen by your teacher. Clean up.

Questions/Conclusions

1. Review the results of the four trials within your group. Contrast the different outcomes to the control experiment. What effect does the heat source have on Trials 2, 3, and 4?
2. For each trial, where in the pan was the current flowing toward the heat source? Where was it flowing away from the heat source?
3. For each trial, where in the pan was the food coloring flowing upward? Where was it flowing downward?